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Reducing Motorpool Oil/Water Separator Management Costs

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14. ABSTRACT

Maintenance of Army oil/water separators (OWS) has been costly because of the sheer number of separators — over 100 at most U.S. Army Forces Command (FORSCOM) installations. While separators are necessary to prevent solids, grease, and oil from entering wastewater treatment systems, seldom do they receive the maintenance required to function properly. Cutbacks in operating budgets have eliminated virtually all routine preventive maintenance of OWS at Army installations. Separators are usually cleaned only when they cause usage of a washrack to be halted. The need to improve separator management and to decrease maintenance requirements is clear.

Headquarters, FORSCOM is aware of the current cost of separator maintenance and the potential cost for upgrading separators. They are also aware that implementation of pollution prevention (P2) measures has the potential to significantly improve OWS management. The Pollution Prevention Compliance group at FORSCOM directed the Construction Engineering Research Laboratory (CERL) to investigate these P2 opportunities. This report and associated reports contain the results and recommendations of that investigation.

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Foreword

This study was conducted for U.S. Army Forces Command (FORSCOM) under Military Interdepartmental Purchase Request (MIPR) W31XNJ90767261, Work Unit NV9, "Demonstrate Oil/Water Separator Evaluation Tools and Evaluate Oil/Water Separator P2 Technologies." The FORSCOM technical monitors were Manette C. Messenger and Ann Gabriel, AFEN-EN.

The work was performed by the Environmental Processes Branch (CN-E) of the Installations Division (CN), Construction Engineering Research Laboratory (CERL). The CERL Principal Investigator was Gary L. Gerdes. The oil/water separator (OWS) cost evaluation Microsoft®-Excel workbook was prepared by Aberdeen Test Center (STEAC-TC) under MIPR W52EU290858737. The technical editor was Linda L. Wheatley, Information Technology Laboratory. Dr. Ilker Adiguzel is Chief, CN-E, and Dr. John T. Bandy is Chief, CN. The associated Technical Director was Gary W. Schanche, CV-T. The Acting Director of CERL is William D. Goran.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Director of ERDC is Dr. James R. Houston and the Commander is COL James S. Weller.

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1 Introduction

Background

Oil/water separators (OWS) seem always to be problematic for installation environmental and maintenance personnel. While separators are necessary to prevent solids, grease, and oil from entering wastewater treatment systems, seldom do they receive the maintenance required to function properly. Problems due to OWS are seldom visible to State Regulators, so acquiring funding to address environmental and maintenance concerns related to OWS has not had a high priority.

Maintenance of OWS has been costly because of the sheer number of separators — over 100 at most U.S. Army Forces Command (FORSCOM) installations. Performing all the maintenance required for optimal separator performance would be even more costly. Even though separator treatment performance depends on proper maintenance, numerous Environmental Program Requirements (EPR) requests for funds to cover maintenance of separators are denied because all funds for routine maintenance must be Operations and Maintenance, Army (OMA). Cutbacks in operating budgets, however, have eliminated virtually all routine preventive maintenance at Army installations. Separators are usually cleaned only when they cause usage of a washrack to be halted. The need to improve separator management and to decrease maintenance requirements is clear.

Unfortunately, the OWS maintenance situation is likely to become worse. Relatively recent pretreatment regulations (Code of Federal Regulations (CFR), Title 40, part 403 [40 CFR 403]), along with the Army's current policy to privatize all utilities, may soon impact OWS management on FORSCOM installations. Certain Publicly Owned Treatment Works (POTWs) are required to have pretreatment programs that set discharge limits on industrial users. Army wastewater systems that are privatized and consolidated with neighboring sanitary districts are likely to then be subject to local pretreatment regulations. These Army installations will have to establish a sampling program to verify OWS performance.

While Federally Owned Treatment Works (FOTWs) are currently exempt from 40 CFR 403, the U.S. Environmental Protection Agency (EPA) and the Army have been negotiating a plan to regulate Army FOTWs. It is possible that FOTWs at large Army installations will be required to have a pretreatment program in place, though it is unlikely that all Army FOTWs will require one.

Development and requirement of pretreatment programs will eventually mean that Army OWS may be regulated as pretreatment devices. Installations may have to prove through monitoring that the performance of their separators will meet regulatory requirements. The need for adequate operation and maintenance of OWS then becomes a compliance issue.

Some State Regulators are already aware of the need for separator maintenance. Maintenance of separators has been included as a requirement in National Pollutant Discharge Elimination System (NPDES) permits. Also, OWS are becoming a target of Environmental Compliance Assessment System (ECAS) audits.

Objectives

Headquarters, FORSCOM is aware of the current cost of separator maintenance and the potential cost for upgrading separators. They are also aware that implementation of pollution prevention (P2) measures has the potential to significantly improve OWS management. The Pollution Prevention Compliance group at FORSCOM directed the Construction Engineering Research Laboratory (CERL) to investigate these P2 opportunities. This report and associated reports contain the results and recommendations of that investigation.

Approach

CERL, an element of the U.S. Army Engineer Research and Development Center (ERDC), conducted surveys at two FORSCOM installations to determine if, and to what extent, implementing P2 measures could decrease OWS management costs. At each installation, locations for all known or suspected separators were inspected. At each site, the survey teams looked for opportunities to implement the following P2 measures:

- Consolidation/closure of washracks
- Consolidation of separators
- Flow reduction
- Elimination of storm inflow

- Increased use of Central Vehicle Wash Facilities (CVWFs)
- Conversion of coalescing separators to simple gravity separators
- Use of recycle treatment systems at motorpool washracks

CERL also determined if separators met current design standards (i.e., determined whether each separator would be expected to provide adequate treatment). During the survey, the usage, condition, and design of each separator were recorded to determine if separators required replacement or upgrading. Implementation of the P2 measures listed above could eliminate the cost of replacing/upgrading existing separators. Gravity separators were determined to have an adequate design if the detention time in the separation chamber was at least 45 minutes (per the Corps of Engineers Engineer Technical Letter [ETL] 1110-3-466, "Selection and Design of Oil/Water Separators at Army Facilities," 26 August 1994).

Detailed results of the two surveys have been prepared in two ERDC/CERL letter reports: *Survey of Fort Lewis Oil/Water Separators* (ERDC/CERL LR-01-2), and *Survey of Fort Stewart and Hunter Army Airfield Oil/Water Separators* (ERDC/CERL LR-01-1). Findings from both reports have been summarized in the following paragraphs and in Chapter 2, **Pollution Prevention Measures**. Some very significant differences will be seen between these two installations regarding infrastructure and management.

CERL was also tasked with developing an aid for evaluating various options for upgrading OWS. This cost evaluation tool is intended to augment the OWS decision tree published in the report prepared by Aberdeen Test Center and CERL for the Army Environmental Center titled, "A Decision Tree for Improving Washrack Oil/Water Separator Operations," January 1998. This tool is in the form of a Microsoft® Excel workbook, and is included with the electronic version of this report. Descriptions of how to use the Excel workbook and how the spreadsheets were derived are included in the appendix to this report.

Types of Separators

This report addresses the management of OWS and grit basins that serve motorpool washracks, maintenance platforms, interior building drains, and fueling areas. Undoubtedly this is over 90 percent of FORSCOM separators. Generally, there are two types of separators — simple gravity and coalescer enhanced. CERL has observed at FORSCOM installations that there are many different configurations of separators. For the most part, the configuration seems to depend on which Corps of Engineer District installed the separator and the year it was installed.

Variations of the construction materials or components of the simple gravity separators are as follows:

- outer shell may be poured concrete, precast concrete, fiberglass, or metal
- interior may have partitions to form chambers, or no partitions
- may be buried below grade with man-way access, or installed on-grade
- if on-grade — top is either open, or covered with metal grates, hinged metal doors, or a concrete slab
- concrete tops may have heavy metal doors or manhole access
- oil storage is in the separation chamber or in a separate integral chamber
- T-pipes, metal baffles, or concrete baffles contain floating oil
- if oil is removed to a separate chamber, it is removed via fixed overflow weirs, moveable slotted pipes, or floating tube skimmers.

Grit basins often have a drive-in ramp allowing access to earth moving equipment. Most other simple gravity separators must be cleaned out using vacuum equipment.

Variations of the coalescing separators are fewer. The outer shell is usually steel or fiberglass, but some are precast concrete; they are usually installed below grade with man-way access, but some have open tops that are grated; coalescers are always difficult to clean and maintain.

The point of this section is to illustrate the wide variety of sizes and designs of separators at FORSCOM installations. A template fix that will solve everyone's problems is simply not possible. The P2 measures that are needed at one installation may not work at another.

Survey Benefits

A survey of OWS is a valuable tool and must be the first step to any separator management cost-reduction/cost-avoidance effort.

An Accurate Inventory

Neither Fort Lewis nor Fort Stewart – Hunter AAF had a concise inventory of OWS at their respective installations. A beneficial result of conducting the surveys was that a fairly accurate inventory of separators has been provided to each of those installations.

Other Benefits

Other survey benefits included: finding industrial discharges to storm drainage; compiling flow estimates and summaries; and arriving at specific recommendations for improving operations at individual washracks.

2 Pollution Prevention Measures

Consolidation/Closure of Washracks

Motorpools constructed before the advent of CVWFs generally have more washing structures than are necessary. Changes in mission and abandonment may also make wash structures unnecessary. These situations present opportunities to close washracks and separators, and thus eliminate associated management costs. Closing washracks that are not covered will also eliminate storm inflow to sewer systems.

There are also cases in large motorpools or multi-motorpool compounds where several units may each have a washrack. Generally, none of the washracks are used extensively, so washing could easily be consolidated to one washrack serving the entire compound.

CERL identified 10 washracks and separators at Fort Lewis that could be closed. At Fort Stewart 24 washracks were identified for possible closure.

Consolidation/Closure of Separators

At the beginning of these studies, CERL researchers thought that there would be locations where washracks in close proximity could share a separator, thus allowing the other separator(s) to be closed. This was not the case, however. At the few locations where the potential for separator consolidation existed, site conditions (primarily pipe elevations) kept this option from being practical. Neither Forts Lewis nor Stewart had locations where consolidation of separators is recommended. Separators that serve multiple washracks already exist at both Forts Lewis and Stewart. Apparently this measure has already been fully implemented.

Flow Reduction

The efficiency of gravity separation depends directly on the detention time of wastewater in the separation chamber. Therefore, as flow through a separator increases, the performance of the separator decreases. As a general rule, it is always good to decrease flow through a separator. At Army washracks, the most common methods to decrease flow are to decrease the diameter of hoses being used or to use low-flow, high-pressure washers.

Fort Lewis has effectively implemented the use of low-flow pressure washers. Almost every washrack had a pressure washer available, and most of them were functioning properly. Fort Lewis has taken the necessary step to guarantee the effectiveness of this P2 measure by establishing a contract for the maintenance of those washers. The estimated average flow to the sanitary sewer from all washrack separators at Fort Lewis is 41 gpm.

The situation at Fort Stewart is much different. Washracks there normally have large grit basins and separators in series. They also have an industrial wastewater collection and treatment system, so there is less incentive to decrease flow. However, high flow hoses at Fort Stewart actually have a negative impact on maintenance costs. Besides the conspicuous water consumption of the 60 gpm hoses, those hoses allow tactical vehicles to be completely washed in the motorpool rather than at the CVWF. Avoiding the CVWF significantly increases the solids accumulation in the grit basins and separators, thus requiring more frequent clean-outs. CERL identified 22 washracks where pressure washers and small diameter hoses should be used at Fort Stewart.

The estimated average wastewater flow from the washrack separators at Fort Stewart is about 520 gpm to the industrial sewer and about 250 gpm to the sanitary sewer. At Hunter, the average flow to the sanitary sewer is 24 gpm. These estimates are based on usage information provided by the motorpool tenants, measurements of flow from wash hoses, and an assumption that washing is done during a 40-hr work week.

Elimination of Storm Water Inflow

Storm water inflow caused by rainfall falling directly on a washrack and separator, and by run-on from paved areas adjacent to the washrack, can be greater than the design capacity of the separator. Storm surges can re-suspend sediment and floating oil and carry those contaminants into the receiving sewer system. It is therefore important that large amounts of sediment and oil not be allowed to accumulate in separators or grit basins in order to maximize the detention volume in the separation chamber. Ideally, separators subject to significant amounts of inflow (greater than the washwater flow) should be cleaned out more frequently to prevent pollutant pass through. Inflow can be prevented by two methods: (1) cover and berm and (2) diversion valve.

Cover and Berm

The first method is to cover the wash area and place berms to prevent run-on. This method is most commonly used by the Army, particularly at smaller washracks. The Corps of Engineers District office at Savannah, GA, has a good design for construction of a new covered washrack with gravity OWS.

Diversion Valve

The second method is to install a storm water diversion valve between the wash area and the grit basin or separator. The diversion valve is set so that when the washrack is not in use, storm water is diverted away from the treatment system to storm drainage. The problem with installing these valves is that they normally depend on the washrack user positioning the valve correctly. If the user does not change the position of the valve before beginning washing, wash water will be improperly (and illegally) discharged to storm drainage.

One company produces an automated version of the storm water diversion valve. The valve is actuated when water flows through the supply line to the washrack. Several variations of this valve are marketed by Wastewater Diversion Systems, Inc. Information on these systems is available at the (Australian) manufacturers' web site at www.foxenviro.com.au. Equipment costs run between $5,000 and $10,000, depending on whether the buyer wants optional features such as collecting "first flush" storm water for treatment. Installation costs will vary significantly depending on the site (i.e., lengths of pipe, amount of concrete to cut, etc).

Storm Water Inflow at Forts Lewis and Stewart

Generally, storm water inflow is not a problem at Fort Lewis because most of the motorpool washracks are covered and bermed. Storm flow reduction was recommended at only six locations. Five sites were motorpools constructed circa 1980 to the present. These motorpools have abandoned fueling areas that still drain to separators discharging to sanitary sewers. At the sixth site, a storm diversion valve was recommended at an aircraft hangar washrack. Estimated stormwater inflow during a 10-yr, 1-hr storm is 441 gpm.

Storm water is more of a concern at Fort Stewart and Hunter AAF because of heavier rains and larger motorpool washracks. Using a 10-yr, 1-hr storm as a reference, CERL calculated instantaneous storm water flow from all washrack OWS to the industrial sewer, sanitary sewer, and storm drainage system.

Storm water flows from washracks at Fort Stewart are as follow:

- 3912 gpm to the industrial sewer
- 1625 gpm to the sanitary sewer
- 455 gpm to storm drainage

Storm water flows from washracks at Hunter AAF are as follow:

- 3298 gpm to the sanitary sewer
- 713 gpm to storm drainage

CERL identified 15 sites where more than 100 gpm would be discharged to the industrial sewer at Fort Stewart, and 5 sites that would discharge more than 100 gpm to the sanitary sewer during a 10-yr, 1-hr storm. At Hunter AAF, 10 sites would discharge more than 100 gpm to the sanitary sewer. The worst case was an airfield washrack at Hunter that alone collected almost 1700 gpm of storm water. A storm water diversion valve is recommended at that site.

Increased Usage of Central Vehicle Wash Facilities

The CVWFs at Forts Lewis and Stewart are underutilized. Many vehicles are washed at motorpool washracks after training exercises instead of at the CVWFs. CVWFs are constructed so the vehicle exteriors can be washed quickly and effectively. Most of the dirt is removed from a vehicle during the exterior wash. For Directorates of Public Works (DPWs), it is much more efficient to remove and dispose of sediment that has collected in large CVWF sedimentation basins than to have the sediment removed from 100 small separators or grit basins scattered across the installation. Sampling costs become considerably lower, also. Water use on post is also lowered significantly when CVWFs with recycling systems are used instead of washracks. For all these reasons, vehicles should not be washed at the motorpools.

At Fort Lewis the reason for vehicles bypassing the CVWFs seemed to be a dysfunctional CVWF operation scheme. Operation of the CVWF rotated among different units in each brigade, and it appeared that no one knew who was operating the facilities at any given time, which made scheduling difficult. When estimating the potential savings that would occur if this P2 measure were implemented, CERL assumed that at least one-third of the sediment that currently accumulates in motorpool separators would accumulate at the CVWF with increased usage. When only maintenance cleaning is done at the motorpools, very little sediment accumulates in separators and grit basins.

At Fort Stewart the CVWF operation runs well, but troop units, especially those with smaller numbers of vehicles, often fail to schedule use of the facility. If the CVWF is in use by another unit or is closed for the day when the unit returns from training, personnel will bypass the facility. Most motorpools at Fort Stewart have washracks with high flow hoses, so washing there is not that inconvenient. Still, because the CVWF is used generally by large groups of vehicles returning from training, the savings in sediment management costs may not be quite as significant as at Fort Lewis. It is estimated that 25 percent of the sediment accumulating at the motorpools could accumulate at the Fort Stewart CVWF if its usage is increased.

Conversion of Coalescing-Type Separators to Simple Gravity

The difference between a simple gravity separator and a coalescing separator is the installation of a pack of parallel plates through which the wash water flow is directed. These plates make gravity separation more efficient, but also make maintenance more difficult. If an OWS can function adequately without a coalescer (i.e., it meets detention recommendations in ETL 1110-3-466), then removing the coalescer will significantly decrease maintenance costs for that separator. Most manufacturers of coalescing separators recommend that the coalescers be removed and cleaned on an annual basis. This recommendation is made because the spaces between the coalescing plates tend to become clogged with sediment and debris, as certainly would be expected at Army washracks.

This P2 measure is applicable only at Fort Lewis. Almost all of the washrack separators there are precast concrete shells with open or grated tops and parallel plate coalescing packs. Fort Stewart and Hunter AAF have very few coalescing separators, and none of them would benefit from removing the coalescers.

All coalescing separator shells at Fort Lewis are large enough to function as simple gravity separators. In fact, most of them could be placed on a 4-yr clean-out frequency as gravity separators, rather than the recommended 1-yr frequency as coalescing separators. The recommended maintenance schedule at Fort Lewis for the existing separators included 59 annual clean-outs. If the survey recommendations are followed, only two would require annual clean-out. Most of the rest would follow a once every 4 years schedule.

Use of Recycle Treatment Systems

Washrack recycle treatment systems are sold by several companies as off-the-shelf equipment. CERL and Aberdeen Test Center evaluated models from the two largest companies and determined that they are very expensive and labor intensive to keep operational (CERL Technical Report 99/25, “Evaluation of Two Washrack Recycle Treatment Systems,” February 1999). This P2 measure is always the last choice for washrack operations. Recycle treatment systems are not recommended for any locations at Fort Lewis or Fort Stewart – Hunter AAF.

3 Summary: Potential Cost Savings

Implementation of the P2 measures described in the previous chapter will decrease the cost of recommended maintenance at both Fort Lewis and Fort Stewart – Hunter AAF. (Refer to ERDC/CERL LR-01-1 and LR-01-2 for more information regarding recommendations specific to each installation.) The costs presented in this chapter are based on the current cost of maintenance according to work order records or contractor fees. Savings are based on the difference between the cost of maintenance that is recommended now and the cost of maintenance that would be recommended after implementation of P2 measures. These cost figures are estimates, often dependent on engineering judgment and subjective information from motorpool personnel. Note that the cost for "status quo" or "current requirements" is based on the cost of maintenance that should be done, not on the cost of maintenance that is actually done.

Fort Lewis

This section compares maintenance schedules with and without a survey having been completed and P2 measures implemented. Table 1 summarizes the data in the two separator maintenance tables from ERDC/CERL LR-01-2 referred to in Chapter 1's **Approach** section.

Table 1. Separator maintenance comparison for Fort Lewis.

	Status Quo	After P2 Measures In Place
No. cleaned once per year	59	2
No. cleaned every 2 years	4	3
No. cleaned every 4 years	4	51
Total separator cleanouts per year	62	16
CVWF basin cleanouts/year	4	4

The average cost per separator cleanout is estimated to be $2,815 based on the existing contract. Because of excess sediment storage capacity at the CVWFs, annual cleanout costs will not change significantly. Comparing annual cost: the status quo is 62 cleanouts x $2,815 = $174,530/year. With recommendations implemented, maintenance will be 16 cleanouts x $2,815 = $45,040/year. In short, by increasing usage of the CVWFs, eliminating unnecessary separators, and removing unnecessary coalescer equipment, recommended separator maintenance can be decreased by 74 percent.

Fort Stewart – Hunter AAF

Table 2. Cost summary – Fort Stewart separator maintenance.

	Current Requirements		With P2 Measures	
Structure	**Cleanout/yr**	**Cost/yr ($)**	**Cleanout/yr**	**Cost/yr ($)**
Grit Basin	165	70,950	47	20,210
Separator w/GB	9	3,600	5	2,000
Separator w/o GB	58	23,200	15	6,000
Total cost/yr		97,750		28,210

It must be noted that these cost figures are estimates that cannot be supported by hard information; they are based entirely on subjective observations. It may be reasonable to conclude, however, that implementing P2 measures could result in a 71 percent reduction in separator cleanout costs (based on recommended clean-out schedules).

Cost to implement P2 measures:

1. Replace large diameter hoses:

   Equipment: Purchase 500 1-in. diameter hoses w/fittings @ $200/hose = $100,000

   Labor: ½ hr/hose @ $30/hr = $7,500

   Total: $107,500

2. Retrofit grit basin outlet weirs:

   Equipment: Materials @ $250/weir for 47 basins = $11,750

   Labor: 16 hr/weir @ $30/hr for 47 basins = $22,560

   Total: $34,310

Note: Fort Stewart had a unique situation in that grit basin weirs were missing or incorrectly installed. The above cost to retrofit the grit basins should not be expected at other installations.

Appendix: Oil/Water Separator (OWS) Upgrade Options and Cost Comparison Spreadsheets

Instructions

Tables A1 through A7 (at the end of the appendix) show seven Microsoft®-Excel worksheets contained within the Oil/Water Separator Upgrade Options and Cost Comparisons Workbook.* Each worksheet in Excel is labeled on the tabs located at the bottom of the screen. The first tab (Table A1), labeled "Comparison Sheet," is a cost comparison sheet that references the total capital and operational costs from all five of the cost estimating worksheets. The cost comparison sheet is for reference only and requires no user input.

For all other sheets, the blocks requiring user input are delineated by a gray background. Make sure that each gray box contains the user's inputs. If no input is required for a certain block, the user should enter "0". These worksheets will reference whatever number is entered in the box. This is also the case for the remainder of the worksheets. The user must pay attention to the units and provide their inputs accordingly.

The second tab (Table A2) is labeled "Closed Loop Washrack." This sheet can be used to estimate the capital and operational costs for either a 15 gallon per minute (gpm) or 30 gpm rated system. This sheet requires user input for the capacity selection, feet of water supply required, feet of electrical supply required, and square yards for desired parking lot size.

* To acquire these electronic MS-Excel files, contact Gary Gerdes, CERL Principal Investigator, at (217) 398-5430, or email gary.l.gerdes@erdc.usace.army.mil.

The third tab (Table A3) labeled "New OWS Installation" provides the capital and operational costs for a total of 12 different options. There are three types of separators to choose from: above ground, in-ground fabricated from concrete, and above ground in a concrete vault (gravity fed). These options are listed in the worksheet below the "Type" input box. ***If the options provided are labeled with a number, input the number, not the name***. This is consistent throughout the remainder of the worksheets. For each type of OWS, there are also four capacities to choose from: 100, 500, 1000, and 2000 gpm. The user simply needs to input the capacity desired. The remainder of the worksheet requires minimal user input. The user must provide their site-specific requirements in each gray box.

The fourth tab (Table A4) labeled "Replace OWS" is very similar to "New OWS Installation" described in the previous paragraph. The only difference in these sheets is that there are costs associated with the removal and disposal of the old OWS. The same rules for user input apply as stated above.

The fifth tab (Table A5) is labeled "Redirect Piping" and can be used to estimate the associated costs of consolidating OWSs. This worksheet requires the most user input of all the worksheets. Users need to make their own assumptions based on the site-specific conditions (pipe lengths, etc).

The sixth tab (Table A6) is labeled "Retrofit Existing Separator." This worksheet applies only to open top, in-ground separators and can be used only for the "AFL Coalescing Tube" type retrofit. This worksheet requires the user to determine the dimensions of available space within the existing separator and to select the type of material composing the coalescing tubes and frame, either standard or aluminum.

The seventh and final tab (Table A7) is labeled "Reference Tables." This worksheet contains all of the information that is referenced for all the calculation worksheets. ***It is very important that the user not edit these sheets***. The information provided on this sheet can easily be updated, but it is very important to know exactly what the tables are referencing.

In summary, the overall instructions are:

- Provide user input into the gray boxes, paying attention to the units of the cost factor.
- For any option from a pick list that is labeled with a number, use the number (not the name) of the selection.
- Do not change the "Reference Tables" worksheet.

- Make sure that all gray boxes contain the information that is desired by the user. If no input is required, input “0” in the gray box.

References

Many different sources were used to compile the cost estimating factors provided in the worksheets. The combination of resources and references include manufacturers, test directors/users, Corp of Engineers (COE), Directorates of Public Works (DPWs), “Means” construction estimating books, actual construction costs from previous projects, some “best engineering judgment” estimates, and other Department of Defense (DOD) installations. Other useful documents that aided in the development of these sheets were the “Oil/Water Separator Guidance Manual,” “Decision Tree for Improving Washrack Oil/Water Separator Operations,” and the Corps of Engineers Design Manual ETL 1110-3-466. The following is a description of how these sources of information were used to develop the cost estimating spreadsheets.

The manufacturers of these treatment systems played a very important role in the development of these cost estimating sheets. The design specifications and pricing provided by a variety of manufacturers were used throughout the sheets. The design specifications were used to determine loading and surface area requirements for the concrete foundations as well as determining excavation requirements to install some of these systems. All unit purchase prices for the OWS and washrack systems are based on an average of the manufacturers’ quotes. Manufacturer information was obtained from Great Lakes Environmental, Pan America Environmental, AFL Industries, Environmental Process Systems, Containment Solutions, LANDA Inc., and RGF Industries.

Other Federal organizations also provided some very useful information. The COE, Baltimore District, provided cost factors used to estimate piping costs, disposal costs of old OWS, and costs to run electrical and water supplies. These cost factors came from a COE, Military Construction Cost Index, from PAX Newsletter #3.2.2, 10 March 2000. The DPW on Aberdeen Proving Ground provided most of the earthwork cost factors. These cost factors included excavation, backfilling, final grade, parking lot, and drive-over berms. Some other DOD installations provided some scattered and inconsistent information on maintenance and disposal costs. These numbers were used to derive rough average cost factors for scheduled and unscheduled maintenance as well as disposal costs.

As with most estimating practices, the “Means” Construction Estimating Books were used. The Means books were used mostly in conjunction with other cost factors either as part of an average or to compare with other factors if possible. The only estimates that were derived solely by using the Means books were for the concrete foundations.

Unfortunately, based on the nature of these types of projects, many assumptions needed to be made. One reason for this is that most OWS systems usually serve as a component of a larger project and their associated construction costs are not broken out from the overall project. Therefore, such things as manhours required for installation, manhours required for pipe installation, etc., are not tracked. Another reason for making assumptions is that many site-specific tasks are associated with the construction of these treatment systems. Variance in site conditions means that estimating items such as trench excavation and sewer connections and disconnections is very difficult.

Most of the assumptions made were to predict the number of manhours needed to complete certain tasks. These assumptions for manhours were made for installation costs, pipe installation, surveying, and hook up to and disconnection from sanitary sewer. Personal knowledge, practical experience, and discussions with other engineers and technical personnel went into these “best guess” estimates.

Table A1. Example of OWS upgrade options and cost comparisons.

Upgrade Options		Associated Costs	
Type		**Capital**	**Operational and maintenance**
Closed Loop Washrack		**$154,700**	**$5,946**
Capacity (GPM)	15		
New Separator		**$95,363**	**$4,140**
Type	Inground Concrete		
Capacity (GPM)	2000		
Replace Separator		**$32,339**	**$4,140**
Type	Inground Concrete		
Capacity (GPM)	100		
Redirect Piping		**$3,354**	**N/A**
Type of Pipe Material	PVC		
Diameter of Pipe Required	12		
Length of Pipe Required	100		
Retrofit Existing Separator		**$2,690**	**$2,700**
(Assumptions: Open Top (vault) or In-ground			
AFL Vertical Coalescing Tube Retrofit)			
Available Space (ft^3)	18		
Type of Material	Aluminum		

Table A2. Closed-loop washrack installation option.

Capacity:	**15**

(Choose one: 15 or 30 gpm)

Total Cost of Closed Loop Washrack:	**$154,700**

Site Preparation				
Task	**Quantity**	**Unit**	**Cost/unit**	**Cost**
Surveying	30	manhr	$40.00	$1,200
Water Supply (assume 2" PVC)	200	ft	$5.00	$1,000
Electric Supply	200	ft	$20.00	$4,000
Pan, Entire foundation and floor	1	each	$89,000.00	$89,000
(Includes all concrete and steel work)				
Parking Lot, Pavement or gravel	10	yd^2	$30.00	$300
			Total:	**$95,500**

Fabrication and Installation Costs				
Item	**Quantity**	**Unit**	**Cost/unit**	**Cost**
Purchasing Items:				
Structure	1	each	$32,000.00	$32,000
Treatment Unit	1	each	$12,800.00	$12,800
Installing Items:				
Structure	160	manhr	$40.00	$6,400
Treatment Unit	160	manhr	$50.00	$8,000
			Total:	**$59,200**

Operational & Maintenance Costs				
Item	**Quantity**	**Unit**	**Cost/Unit**	**Cost**
Operational:				
Water Consumption				
Electrical Consumption				
Maintenance:				
Scheduled				
Unscheduled				
Consumables:				
Carbon	6	50 lb	$99.00	$594
Cartridge Element	8	each	$180.00	$1,440
Disposable Sludge Bags (pkg 5)	24	each	$13.00	$312
Sodium Hypochlorite	4	55 gal	$200.00	$800
Aluminum Sulfate liquid	4	55 gal	$200.00	$800
Disposal:				
Filter Media				
oily waste and sediment				
Training		flat rate		$2,000
			Total:	**$5,946**

Notes:

* All consumables are based on a yearly estimate.

Table A3. Option for 2000 gallon OWS installation.

Type: 3
(Options: (2) above ground, (3) in ground fabricated from concrete, (4) above ground type in concrete vault)
Capacity: 2000
(Options: 100, 500, 1000, 2000 gallon)

Total Cost of New OWS: **$95,363**

Site Preparation				
Task	**Quantity**	**Unit**	**Cost/unit**	**Cost**
Survey	10	manhr	$50.00	$500
Excavation	1188	yd^3	$6.00	$7,128
*** Foundation**				$1,900
Electric Supply (If applicable)	400	ft	$20.00	$8,000
Sewer Pipe installation:				
Select Type: (2) concrete or (3) PVC	2			
Input amount req'd	500	ft	$19.50	$9,750
Trench excavation (assuming 8' deep x 3' wide)	444	yd^3	$6.50	$2,889
Hook up to sanitary sewer	24	manhr	$50.00	$1,200
Parking Lot (gravel or pavement)	10	yd^2	$30.00	$300
			Total:	**$31,667**

Operational & Maintenance Costs				
Item	**Quantity**	**Unit**	**Cost/Unit**	**Cost**
Maintenance:				
Scheduled (cleaning)	1	year	$1,500	$1,500
Unscheduled	1	year	$500	$500
Disposal:				
oily waste and sediment	1	year	$1,500	$1,500
Training:	16	hr	$40	$640
(Using train the trainer method)				
			Total:	**$4,140**

Fabrication and Installation Costs				
Item	**Quantity**	**Unit**	**Cost/unit**	**Cost**
Purchasing OWS:	1	each	$52,700.00	52,700
Installing OWS:				
Install OWS	96	manhr	$40.00	3,840
Connect to sanitary sewer	24	manhr	$40.00	960
Backfill (including pipe)	744	yd^3	$6.00	5,807
Final grade	250	yd^2	$0.60	150
Divert Stormwater:				
Drive over berms	190	ft	$1.26	239
Stormwater diversion valve		each		
			Total:	**63,696**

Assumptions:
* Foundation and all excavation requirements are totally site dependent. The figures provided are rough estimates.
* Sanitary sewer disconnections and connections are also totally site dependent. Figures provided are rough estimates.

Table A4. Option for replacing 100-gallon OWS.

Type: **3**
(Options: (2) above ground, (3) in ground fabricated from concrete, (4) above ground type in concrete vault)
Capacity: **100**
(Options: 100, 500, 1000, 2000 gallon)

Total Cost to Replace OWS: **$32,339**

Site Preparation				
Task	**Quantity**	**Unit**	**Cost/unit**	**Cost**
Removal of old OWS:				
Excavation	20	yd^3	$6.00	$120
Disconnect from sanitary sewer	24	manhr	$40.00	$960
Disposal Costs:		lb	$0.10	$0
Old OWS, (includes removal and disposal)	20	yd^3	$40.00	$792
Contaminated Excavated Soil				
Survey	10	manhr	$50.00	$500
Excavation (additional needed)		yd^3	$6.00	$0
Foundation				$466
Electric Supply (If applicable)	1000	ft	$20.00	$20,000
Pipe installation:				
Select Type: (2) concrete or (3) PVC	2			
Input linear ft required	50	yd^3	$12.00	$600
Trench Excavation	44	yd^3	$6.50	$289
Parking Lot (gravel or pavement)	30	yd^2	$30.00	$900
			Total:	**$24,627**

Fabrication and Installation Costs				
Item	**Quantity**	**Unit**	**Cost/unit**	**Cost**
Purchasing OWS:	1	each		$4,990
Installing OWS:	1			
Install OWS	24	manhr	$40.00	$960
Connect to sanitary sewer	24	manhr	$40.00	$960
Backfill	64	yd^3	$6.00	$503
Final grade	170	yd^2	$0.60	$102
Divert Stormwater:				
Drive over berms	156.46	ft	$1.26	$197
Stormwater diversion valve		each		
			Total:	**$7,712**

Operational & Maintenance Costs				
Item	**Quantity**	**Unit**	**Cost/Unit**	**Cost**
Maintenance:				
Scheduled (cleaning)	1	year	$1,500.00	$1,500
Unscheduled	1	year	$500.00	$500
Disposal:				
oily waste and sediment	1	year	$1,500.00	$1,500
Training:				
(Using train the trainer method)	16	hr	$40.00	$640
			Total:	**$4,140**

Table A5. Option for consolidating OWS and redirecting piping.

Associated Costs				
Task	**Quantity**	**Unit**	**Cost/unit**	**Cost**
Removal of old separator:				
Excavation	10	yd^3	$6.00	$60
Disconnecting from sanitary sewer		manhr		
Disposal:				
Old OWS (Includes removal and disposal)	5	yd^3	$40.00	$200
Contaminated soils (If applicable)				
New pipe installation:				
Required pipe size (6", 10", 12", or 18")	12			
Type of Pipe: Choose one (2) PVC or (3) Concrete	2			
Amount of Pipe Required	100	ft	$24.50	$2,450
Trench excavation	89	yd^3	$6.50	$578
Connecting to OWS		manhr	$40.00	
Backfilling for new Pipe and old OWS	10	yd^3	$6.00	$60
Final Grade	10	yd^2	$0.60	$6
			Total:	**$3,354**

Table A6. Retrofit option.

Type of OWS: Open Top (vault) or In-ground

Type of Retrofit: AFL Vertical Coalescing Tube Retrofit

Dimensions of available space in OWS for retrofit (ft)	**length**	**width**	**height**
	2	**3**	**3**

Material to be used for retrofit:	**2**

Choose one: (1) standard (2) Aluminum

Associated Costs					**Operational & Maintenance Costs**				
Item	**Quantity**	**Unit**	**Cost/unit**	**Cost**	**Item**	**Quantity**	**Unit**	**Cost/Unit**	**Cost**
Purchasing coalescing tube material:					**Maintenance:**				
(Includes tubes and frame)					Scheduled (cleaning)	1	year	$1,000	$1,000
Standard	18	ft^3	$80	$1,440	Unscheduled	1	year	$500	$500
Aluminum	18	ft^3	$105	$1,890	**Disposal:**				
					Oily waste and sediment	4	55 gallons	$300	$1,200
Installing coalescing tube retrofit:	16	manhr	$50	$800					
			Total:	**$2,690**				**Total:**	**$2,700**

Assumptions:

Adequate grit basin proceeds separator

Separator has adequate structural integrity

Open top separator

Inground separator

Material costs and engineering based upon manufacturers quotes

Table A7. Reference for Tables A1 – A6.

Cost of OWS Table:			
Capacity	Above ground (2)	Inground concrete (3)	Above ground concrete (4)
100	12,500	4990	12,500
500	47200	14200	47200
1000	100,625	27950	100,625
2000	200,000	52700	200,000

Excavation required (yd^3) based on type and size Table:			
Capacity	Above ground (2)	Inground concrete (3)	Above ground concrete (4)
100	0	60	67
500	0	298	168
1000	0	595	288
2000	0	1188	450

Installation Time (manhr) Table:			
Capacity	Above ground (2)	Inground concrete (3)	Above ground concrete (4)
100	24	24	24
500	30	48	48
1000	40	72	72
2000	60	96	96

OWS disposal materials based on size and type Table:			
Capacity	Above ground (2)	Inground concrete (3)	Above ground concrete (4)
100	4	19.8	
500	13	99	
1000	23	198	
2000	46	396	

Volume of backfill required (yd^3) based on type and size			
Capacity	Above ground (2)	Inground concrete (3)	Above ground concrete (4)
100	0	20	30
500	0	100	67
1000	0	190	77
2000	0	300	160

Surface area disturbed (yd^2) based on type and size			
Capacity	Above ground (2)	Inground concrete (3)	Above ground concrete (4)
100	0	20	28
500	0	100	71
1000	0	190	77
2000	0	250	118

Cost per foot of pipe based on diameter and type			
Pipe dia.	Concrete (2)	PVC (3)	
6	12	15	
10	14	19.5	
12	15.5	24.5	
18	19.5	not available	

Foundation costs			
Capacity	Above ground (2)	Inground concrete (3)	Above ground concrete (4)
100	466	466	

500	950	950	
1000	1300	1300	
2000	1900	1900	

Pipe sizes with associated costs for “Redirecting Piping” Table:			
Dia.	PVC (2)	Concrete (3)	
6	15	12	
10	19.5	14	
12	24.5	15.5	
18	NA	19.5	

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